PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 40263	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/IB2004/002209	International filing date *(day/month/year)* 05.07.2004	Priority date *(day/month/year)* 04.07.2003
International Patent Classification (IPC) or national classification and IPC F27B7/36, F27D7/04, B01F5/04		
Applicant HOLCIM LTD.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 9 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand 31.05.2005	Date of completion of this report 11.10.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Peis, S Telephone No. +31 70 340-4265

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/IB2004/002209

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:

   ☐ international search (under Rules 12.3 and 23.1(b))
   ☐ publication of the international application (under Rule 12.4)
   ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages	
1-39	as originally filed
Claims, Numbers	
1-61	filed with telefax on 31.05.2005
Drawings, Sheets	
1/9-9/9	as originally filed

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:

   ☐ the description, pages
   ☐ the claims, Nos.
   ☐ the drawings, sheets/figs
   ☐ the sequence listing *(specify)*:
   ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

   ☐ the description, pages
   ☐ the claims, Nos.
   ☐ the drawings, sheets/figs
   ☐ the sequence listing *(specify)*:
   ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/IB2004/002209

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	3-10, 13, 16-22, 25-28, 40-46, 48-59
	No:	Claims	1, 2, 11, 12, 14, 15, 23, 24, 29, 31-38, 39, 44,47, 60-61
Inventive step (IS)	Yes:	Claims	
	No:	Claims	3-10, 13, 16-22, 25-28, 40-46, 48-59
Industrial applicability (IA)	Yes:	Claims	1-61
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V.

The following documents are referred to in this communication:

D1: JP 05 223228 A
D1a : PATENT ABSTRACTS OF JAPAN vol. 017, no. 671, abstract of D1
D2 : EP 0 579 987 A

1 Clarity (Article 6 PCT)

As explained below, some of the features in the apparatus claims 1, 9, 11 and 12 relate to a method of using the apparatus rather than clearly defining the apparatus in terms of its technical features. The intended limitations are therfore not clear , contrary to the requirements of Article 6 PCT.

In claims 1 and 11: "...said predetermined pressure are arranged...at sufficiently high momentum...".

In claims 9 and 12: "...said process gas flow is substantially entrained...before the injected gas flow is converted...".

2 Novelty (Article 33(1)(2) PCT)

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of independent claims 1, 37 and 44 is not new in the sense of Article 33(2) PCT.

2.1.1 Document D1 discloses a rotary drum furnace for burning waste. There are several secondary air nozzles arranged around the drum of the furnace through which air is injected for mixing the combustion gas. The nozzles are arranged in such a way, that injected air, which is delivered by an air supply system, impinges tangentially on a circle centered on said axis of said process gas flow (figures 1 and 2, ref. sign 3). By doing that,

the injected gas is swirling like the combustion gas. Thus, the secondary air nozzles is seen as a swirling means, i.e. a means suitable for imparting a swirl to said injected gas as it enters the housing.
Furthermore, the nozzles are arranged in such a way, that they are covering 5 to 15 percent of the cross sectional area of combustion gas flow (§[0011]).

Thus document D1 discloses all the technical features of independent claims 1 and 37, these claims 1, 37 and 44 are not new with respect to document D1.

2.1.2 Independently of the above, document D2 discloses a rotary drum furnace with a post-combustion chamber. There are several nozzles arranged around the rotary drum furnace but also around the post-combustion chamber for injecting air and mixing the combustion gases by bringing them into turbulence (figures 3-4, ref. signs 20, 22, 30, 32 and 33; column 2, line 31-51). By doing that, the injected gas is swirling like the combustion gas. Thus, the secondary air nozzles has to be seen as a means suitable for imparting a swirl to said injected gas as it enters the housing.
Thus document D2 discloses all the technical features of independent claims 1, 37 and 44; said claims are not new with respect to document D2.

2.2 Dependent claims 2, 10-14, 21, 22, 27, 29-36, 45, 46 and 57-61 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of Article 33(1)(2) PCT in respect of novelty, the reasons being as follows:

Document D1 discloses a plurality of secondary air nozzles as injectors.
Further the nozzles are arranged in such a way, that they are covering 5 to 15 percent of the cross sectional area of combustion gas flow (§[0011]).
The nozzles are directed at an angle between 25 to 40° (figure 1).
The injected gas is air (§[0008].
The rotary drum furnace is suitable for preparing cement clinker, whereby the gas temperatur is between 1000° to 1250°C.
The rotary drum furnace includes a system for mixing the process gas in form of a plurality secondary air nozzles, which are also suitable for the use in a precalciner of a kiln system,

an exhaust system for a kiln, a preheater section of a kiln system and a gas rising duct of a kiln system.

Thus dependent claims 2, 10-14, 21, 22, 27, 29-36, 45, 46 and 57-61 are not new with respect to document D1.

3 Inventive step (Article 33(1)(3) PCT)

In dependent claims 3-9, 15-20, 23-26, 28, 38-43 and 47-56 slight constructional changes or changes in the method are defined, which are merely one or more of several straightforward possibilities from which the skilled person would select, in accordance with circumstances, without the excercise of inventive skill, in order to solve the problem posed. Consequently, the subject-matter of claims 3-9, 15-20, 23-26, 28, 38-43 and 47-56 lacks an inventive step over document D1, which is considered to be the closest prior art.

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C L A I M S

1. A system for mixing a process gas flow that is flowing through a housing (92) of a kiln system (20), said system comprising:

at least one injector (84,86) provided to said housing (94);

a gas supply system (102) connected to said at least one injector (84,86) for supplying injection gas to said injector (84,86) at a predetermined pressure; and

wherein said injector (84,86) and said predetermined pressure are arranged and selected to inject said injection gas into the housing (92) at sufficiently high momentum to produce a jet having the appropriate turbulent flow characteristics such that the process gas flow is entrained by said injected gas; and

wherein said injector (84,86) is provided with swirling means for providing axial swirl to said injected gas

2. A system according to claim 1, wherein the injector is arranged so that the gas flow is flowing through a housing (92) along an axis of said housing (92).

3. A system according to claim 1 or 2, wherein said swirling means comprises swirl vanes (100).

4. A system according to claim 3, wherein said swirl vanes (100) have an angle of approximately 10 to 35 degrees.

5. A system according to any of claims 1 to 4, wherein said injector (84,86) is provided with flare diffusers to enhance said entrainment.

6. A system according to any of claims 1 to 4, wherein said injector is provided with a bluff body to enhance said entrainment.

7. A system according to any of claims 1 to 4, wherein said injector is provided with a bluff body and flare diffusers to enhance said entrainment.

8. A system according to either of claims 5 or 7, wherein said flare diffusers are at approximately 5 to 20 degree half angles.

9. A system according to any prior claim, wherein said process gas flow is substantially entrained before the injected gas flow is converted to plug flow along with the process gas flow or before the injected gas flow impinges upon the interior of the housing (92).

10. A system according to any of claims 1 to 9, said system comprising:

a plurality of injectors (84,86) provided to said housing (92) and arranged at predetermined intervals around a cross section of said process gas flow and in communication with the interior of said housing (92); and

a gas supply system (102) for supplying injection gas to said injectors at a predetermined pressure,

wherein said injectors (84,86) are directed to inject said injection gas to impinge tangentially on a circle (98) centered on said axis of said process gas flow and covering at least approximately 5 to 15 percent of the cross sectional area of said process gas flow.

11. A system according to claim 10, wherein said plurality of injectors (84,86) and said predetermined pressure are arranged and selected to inject said injection gas into the housing (92) at sufficiently high momentum to produce a jet having the appropriate turbulent flow characteristics such that the process gas flow is entrained by the injected gas.

12. A system according to claim 11, wherein said process gas flow is substantially entrained before the injected gas

flow is converted to plug flow along with the process gas flow or before the injected gas flow impinges upon the interior of the housing (92).

13. A system according to either of claims 10 or 11, wherein said circle (98) covers at least approximately 5 percent of the cross sectional area of said housing (92).

14. A system according to either of claims 10 or 11, wherein said circle (98) covers approximately 10 percent of the cross sectional area of said housing (92).

15. A system according to any of claims 10 to 14, wherein said swirling means comprises swirl vanes (100).

16. A system according to claim 15, wherein said swirl vanes (100) have an angle of approximately 10 to 35 degrees.

17. A system according to any of claims 10 to 16, wherein said injectors (84,86) are provided with flare diffusers.

18. A system according to any of claims 10 to 16, wherein said injectors (84,86) are provided with bluff bodies.

19. A system according to any of claims 10 to 16, wherein said injectors (84,86) are provided with bluff bodies and flare diffusers.

20. A system according to either of claims 17 or 19, wherein said flare diffusers are at approximately 5 to 20 degree half angles.

21. A system according to any of claims 10 to 20, wherein said plurality of injectors (86) are directed at an angle of approximately 0 to 60 degrees in the direction of process gas flow.

22. A system according to claim 21, wherein said plurality of injectors (86) are directed at an angle of approximately 25 to 40 degrees in the direction of process gas flow.

23. A system according to any of claims 10 to 22, wherein said plurality of injectors (86) comprise a first set of injectors (86) and said system further comprises a second set of injectors (103) comprising:

at least one injector (103) provided to said housing, arranged at a second cross section of said housing (92) and in communication with the interior of said housing (92), and

a second gas supply system for supplying injection gas to said at least one injector (103) at a predetermined pressure,

wherein said at least one injector (103) is directed to inject gas to impinge tangentially on a second circle (104) centered on said axis of said housing (92) that has a different diameter than the circle (98) of said first set (86) of injectors.

24. A system according to claim 23, wherein said second circle (104) has a larger diameter than said circle (88).

25. A system according to either of claims 23 or 24, wherein said second cross section of said housing (92) is spaced apart from said cross section of said first set of injectors (86) in the direction of process gas flow.

26. A system according to claim 23, wherein said gas supply system (102) for said first set of injectors further comprises said second gas supply system.

27. A system according to any prior claim, wherein said injected gas is air or oxygenated air.

28. A system according to any prior claim, wherein said injected gases may be preheated.

29. A system according to any prior claim, wherein said kiln system (20) is for preparing cement clinker and said system is in a region of said kiln system (20) where the gas

temperature is between approximately 850 to 1400 degrees Celsius.

30. A system according to claim 29, wherein said gas temperature is between approximately 1000 to 1250 degrees Celsius.

31. A system according to any prior claim, wherein said housing (92) is a housing of a rotary kiln (42).

32. A system according to any of claims 1 to 30, wherein said housing (92) is a housing of an exhaust gas by-pass system.

33. A system according to claims 1 to 30, wherein said housing (92) is a housing of a precalciner.

34. A system according to any of claims 1 to 29, wherein said housing (92) is a housing of a gas riser duct (34).

35. A system according to any of claims 1 to 29, wherein said housing (92) is a housing of a precalciner in a region near a gas exit where said gas temperature is between approximately 900 to 1250 degrees Celsius.

36. A system according to any of claims 1 to 29, wherein said housing (92) is a housing of said kiln system (20) in a region in which said system will enhance the efficiency and completion of reactions with ammonia where said gas temperature is between approximately 850 to 1050 degrees Celsius.

37. A method of mixing a process gas flow of a kiln system comprising:

providing a source of injection gas at high pressure; and

injecting said injection gas into said process gas flow via at least one injector at sufficiently high momentum to

produce a jet having appropriate turbulent flow characteristics such that the process gas flow is entrained by the injected gas;

further comprising imparting swirl to said injected gas as it enters the housing.

38. A method of mixing a process gas flow according to claim 37, wherein said swirl is imparted by swirl vanes provided to said at least one injector.

39. A method of mixing a process gas flow according to any of claims 37 to 38, wherein said entrainment is further enhanced by a bluff body provided to said at least one injector.

40. A method of mixing a process gas flow according to any of claims 37 to 38, wherein said entrainment is further enhanced by a flare diffuser provided to said at least one injector.

41. A system according to any of claims 37 to 38, wherein said entrainment is further enhanced by a bluff body and a flare diffuser provided to said at least one injector.

42. A method of mixing a process gas flow according to any of claims 37 to 41, wherein the total momentum of said injected gas during injection is approximately 50 to 150% of the momentum of said process gas flow.

43. A method of mixing a process gas flow according to any of claims 37 to 42, wherein said injected gas is injected at or above approximately 150 meters/second.

44. A method of mixing a process gas flow in a housing of a kiln system comprising:

providing a source of injection gas at high pressure; and

injecting said injection gas into said housing via at least one injector such that said injection gas impinges tangentially on a circle centered on said axis of said process gas flow and covering at least approximately 5 to 15 percent of the cross sectional area of said process gas flow.

45. A method of mixing a process gas flow according to claim 44, wherein said injecting of said injection gas into said process gas flow is at sufficiently high momentum to produce a jet having appropriate turbulent flow characteristics such that the process gas flow is entrained by the injected gas.

46. A method of mixing a process gas flow according to either of claims 44 or 45, further comprising imparting swirl to said injection gas as it enters the housing.

47. A method of mixing a process gas flow according to claim 45, wherein said swirl is imparted by swirl vanes provided to said at least one injector.

48. A method of mixing a process gas flow according to any of claims 45 to 47, wherein said entrainment is further enhanced by a bluff body provided said at least one injector.

49. A method of mixing a process gas flow according to any of claims 45 to 47, wherein said entrainment is further enhanced by a flare diffuser provided to said at least one injector.

50. A method of mixing a process gas flow according to any of claims 45 to 47, wherein said entrainment is further enhanced by a bluff body and a flare diffuser provided to said at least one injector.

51. A method of mixing a process gas flow according to any of claims 45 to 50, wherein the total momentum of said

injection gas during injection is approximately 50 to 150% of the momentum of said process gas flow.

52. A method of mixing a process gas flow according to any of claims 44 to 51, wherein said injection gas is injected at or above approximately 150 meters/second.

53. A method of mixing a process gas flow of a kiln system according to claim 44, wherein the Reynolds Number due to said mixing is approximately 2.5 times above that encountered in the typical process gas flow without said mixing.

54. A method of mixing a process gas flow of a kiln system according to claim 44, wherein the turbulent frequency due to said mixing is approximately 100 times above that encountered in the typical process gas flow without mixing.

55. A method of mixing a process gas flow of a kiln system according to claim 44, wherein a total momentum, turbulence and swirl of said injected gas are selected based on aerodynamic calculation such that said injected gas will substantially entrain the whole of said process gas flow before the injected gas flow is converted to plug flow along with the process gas flow or before the injected gas flow impinges upon the interior of the housing.

56. A method of mixing a process gas flow of a kiln system according to claim 44, wherein a total momentum, turbulence and swirl of said injected gas are selected based on mathematical modelling such that said injected gas will substantially entrain the whole of said process gas flow before the injected gas flow is converted to plug flow along with the process gas flow or before the injected gas flow impinges upon the interior of the housing.

57. A rotary kiln of a kiln system provided with a system for mixing a process gas flow according to any of claims 1 to 30.

58. A precalciner of a kiln system provided with a system for mixing a process gas flow according to any of claims 1 to 30.

59. An exhaust has by-pass system of a kiln system provided with a system for mixing a process gas flow according to any of claims 1 to 30.

60. A preheater section of a kiln system provided with a system for mixing a process gas flow according to any of claims 1 to 29.

61. A gas riser duct of a kiln system provided with a system for mixing a process gas flow according to any of claims 1 to 29.